Discussion Analytics: Identifying Conversations and Social Learners in FutureLearn MOOCs

Conference or Workshop Item

Discussion Analytics: Identifying Conversations and Social Learners in FutureLearn MOOCs

Shi Min Chua[1], Caroline Tagg[2], Mike Sharples[1], Bart Rienties[1]
[1]Institute of Educational Technology
[2]Faculty of Wellbeing, Education and Language Studies
The Open University
Milton Keynes, MK7 6AA, UK
+44- 1908 655581
shimin.chua@ou.ac.uk, caroline.tagg@ou.ac.uk, mike.sharples@ou.ac.uk, bart.rienties@ou.ac.uk

ABSTRACT

Discussion among learners in MOOCs has been hailed as beneficial for social constructive learning. To understand the pedagogical value of MOOC discussion forums, several researchers have utilized content analysis techniques to associate individual postings with differing levels of cognitive activity. However, this analysis typically ignores the dynamics of discussion postings, such as learners responding to replies by others to their original posts, or learners receiving no reply after posting. This information is particularly important in understanding patterns of conversations that occur in MOOCs, especially to understand whether learners just post rather than converse with each other. Therefore, in this paper, we categorize comments in a FutureLearn MOOC based on their nature (*new post vs. reply to others' post*) and the replies each comment receives, classifying learners based on their contributions for each type of posting, and identifying conversations based on the types of comments composing them. This categorization quantifies the social dynamics in the discussion activities, allowing monitoring of on-going discussion activities in FutureLearn and further analysis on identified conversations, social learners, and types of comments with an unusual number in a course step.

CCS Concepts

• **Applied computing~ Collaborative learning**

Keywords

MOOCs; Computer-mediated Collaborative Learning; Learning Analytics; FutureLearn

1. INTRODUCTION

Discussion forums in Massive Open Online Courses (MOOCs) have attracted research interest since the beginning of MOOCs, particularly in the LAK community [26, 28]. This could be due to two reasons. Firstly, enormous text data are easily available for analysis, either by manual coding, text mining or natural language processing (e.g., [14, 19, 26, 28]). The general findings from these content analyses are that postings in MOOC discussion forums indicate different levels of cognitive thinking. For example, Kellogg and colleagues [14] found that, in the two MOOCs for school teachers on digital learning and mathematics learning they analyzed, 2 to 3% of the discussion postings achieve the highest phase of knowledge construction. Secondly, discussion among learners and educators in MOOCs is an important element of social constructive learning because it allows learners with varied experience and expertise from around the world to interact with each other [4]. Yet, this apparent advantage of discussion in MOOCs has been undermined by concerns about educators and learners being overwhelmed by the sheer number of postings, lack of focus on what is being discussed, lack of "appropriate" comments or responses (likes or replies) from educators and peers [12, 20, 28], and lack of in-depth discussion or recurrent interaction [6, 22, 25]. These drawbacks warrant further research to improve the discussion experiences of MOOC learners. To provide a basis for future learning analytics and qualitative research on discussion activities in FutureLearn, a relatively new MOOC platform that has not received as much research coverage as Edx or Coursera in LAK community, we propose an approach to categorize learners' discussion postings and their posting behaviours based on the discussion structure afforded by the FutureLearn platform. As will be discussed next, discussion activities in FutureLearn is different from the discussion forums used in other MOOC platforms, so a categorization approach tailored to its unique discussion function is needed for analytics and other research purposes [11]. After introducing FutureLearn, previous research on MOOC discussion will be reviewed before the proposed categorization is presented. We then explore how this categorization could be used in both quantitative and qualitative analysis to study the social interaction and discourse in a FutureLearn MOOC, and how educators and course designers could use the analytics for discussion monitoring and course revision.

DOI: http://dx.doi.org/10.1145/12345.67890

2. FUTURELEARN

In FutureLearn, a discussion area is attached to each course step, except in steps for quizzes and exercises. Learners are encouraged to share their experience, contribute their reflection, discuss issues raised in the course step, and interact with others in the discussion area right below or beside the course content [4, 22]. The focus of the discussion is dictated by the discussion prompt or the course content in that step, thus creating a shared attention for social learning among learners [6, 22]. This discussion function is different from the centralized discussion forum used in other MOOC platforms such as EdX and Coursera [13, 28], which is independent of the course step. The "discussion in context" approach taken by FutureLearn may be able to overcome the

problem of lack of focus in MOOC discussion, one of the problems mentioned in the introduction.

This "discussion in context" approach also allows educators to design each step of the learning journey to support learners' conversations with themselves and others by building on their previous experience and existing knowledge while going through the course, in accordance with Laurillard's Conversational Framework [15, 16].The conversational framework operationalizes learning as an iterative process between reflecting within oneself and conversing with educators and others, while also interacting with the outside world. The process starts with learners' initial description of concepts. Through interaction with content, activities, or peers, learners adapt their initial understanding and expand their knowledge. Based on this framework, learning happens through the whole process, not only relying on discussion with others and feedback, but also involving reflective conversation within learners themselves during the process. Similarly, clarification of concepts and sharing experience are as important as evaluating and debating with each other.

According to Laurillard [16], for the learning process of conversation with oneself and others to be successful, good learning design is needed. Different questions, prompts, course media may be designed to lead learners through a journey of initial reflection with concepts, interaction with content, others or practice environments, and finally synthesis or critical thinking of what has been learned. Under this framework, a discussion function that is attached to each stage of learning is needed, instead of a centralized discussion forum that relies on learners' initiative to raise topics or questions. Therefore, the FutureLearn "discussion in context" approach may be warranted to achieve the cycle of Laurillard's conversational framework, and can be a suitable testbed to examine how course step design may invoke different kinds of discussion postings during a learning journey, which is one of the research question considered in this paper.

3. PREVIOUS RESEARCH

Several frameworks have been used in previous content analysis research (e.g., [14, 19, 27]) to categorize discussion postings in MOOCs into lower and higher order thinking within a fixed number of levels. This method is based on the assumption that discussion postings are indicative of learning processes [8], learners' interaction [5, 8], critical thinking [5] or learning goals [1]. For example, Henri's framework [8] consisted of five levels: participation, interaction, social, cognitive and metacognitive. Categorization of discussion postings based on these frameworks typically privileges the highest levels and is used to evaluate the quality of discussion. This emphasis is in contrast to Laurillard's framework, which values all the different kinds of conversation which comprise the cycle of the learning process.

Undeniably, the categorization of discussion postings based on these content analysis frameworks is beneficial for educators to understand the discussion that has happened in their MOOCs. For example, Kellogg and colleagues [14] found that around 40% of the discussion comments in their MOOCs were sharing and around 3% are metacognitive. However, as indicated by [16, 21, 26], an analysis at the course level may not be helpful in the search for a theoretical or design explanation about the distribution of the comments of differing cognitive levels. One way of tackling this issue is to associate the content analysis with the course step design.

Furthermore, categorizing discussion postings by using the content analysis frameworks mentioned above may mask the dynamics and social engagement among learners, because this method normally codes individual postings without recognizing turn-taking, replying, lone postings, or heated discussions. Understanding the social dynamics in MOOC discussion is utmost important when it comes to designing course steps to generate either conversations with oneself or others, in accordance to Laurillard's conversational framework. At the same time, it will also reveal the extent to which learners interact with each other, addressing the issue of learners only contributing new postings without replying to others in online discussion [24, 28]. Visualizing social engagement in the discussion of each course step and classifying learners of different posting behaviours also allows educators or mentors to facilitate social learning during the course periods. Lastly, identifying postings of different social dynamics may set up the next step for in-depth content analysis, discourse analysis, conversational analysis or linguistic analysis [10, 11] that will inform the nature of social constructive learning in MOOC discussion. Therefore, we are proposing categorizing learners' comments in FutureLearn based on their interaction features.

4. CATEGORIZING LEARNERS' COMMENTS IN FUTURELEARN

As mentioned earlier, in FutureLearn learners are encouraged to post their discussions (labelled as comments in FutureLearn) under or beside the content of each course step, except in steps for quizzes and exercises. The commenting area takes a simple structure, differentiating between new posts and replies only. There is no hierarchical structure amongst replies under a new post, and the replies are ordered by the time of posting. Learners receive notification by email when somebody replies under their new posts, or replies after their reply under the same new post. Based on this commenting structure, each comment could be classified into one of the five categories:

1. **Initiating posts**: New posts that receive replies
2. **Lone posts**: New posts that receive no replies
3. **Replies**: Replies to others' initiating post
4. **Responses**: Responses to others' replies to one's own initiating post
5. **Further replies**: Further replies under an initiating post that one has already replied to, i.e., the learners replied more than one time under an initiating post.

These five categories capture turn-taking in online interaction that is somewhat shaped by the FutureLearn platform [9, 10], despite it being not as neat as it could have been if content had been taken into account [8]. Nonetheless, we argue that these five categories could be used as a proxy for social engagement and discussion dynamics among learners. An initiating post indicates the start of a conversation, assuming a conversation consists of at least two turns, *i.e.*, the post and one reply. A lone post implies no explicit interaction among learners. Lone posts also include the replies posted by the same learner in response to his/her new post, where no other learners reply to that post. Yet, lone posts could be read and 'liked' by many learners, suggesting an implicit interaction among learners. A reply is an explicit interaction between at least two learners. A response or further reply shows that learners do get back to each other on the issue raised in their posts or replies, in other words a turn-taking.

5. RESEARCH QUESTIONS

To illustrate how this categorization approach could help educators and researchers in understanding the social dynamics in the discussion activities in FutureLearn, we are going to apply this categorization to one FutureLearn MOOC and conduct both

quantitative analysis and qualitative analysis to explore the following questions:

1. What are the characteristics of conversations occurring in the FutureLearn discussions?
2. Are there different groups of social learners with distinctive commenting behaviours?
3. Is there a relationship between course step design and distribution of comment types?

By addressing these questions, a learning analytic approach is realized by quantifying the social engagement and discussion dynamics in terms of the distribution of different types of comments, conversations and social learners. Educators could then make use of this information for their revision of course step design in the future run of their course, or for their intervention of on-going discussion activities. Prototype dashboards showing the analytics are presented after we address each research question.

6. METHODS

6.1 Data Set

The comments data to be analyzed are from the first run of the FutureLearn Course "Challenging Wealth and Income Inequality" offered by The Open University. The course lasted for four weeks, yet the data captured is available from the start of the course until two weeks after the course period ends. There were 1956 learners, 641 (33%) of whom were social learners that contributed 10396 comments. Based on the definition offered by FutureLearn, learners are those who visit at least one step of the course, whereas social learners comment at least once in the course. It should be noted that we are analyzing the comments data, so only social learners, rather than all learners, were included in the present study. Social learners did not necessarily comment in each course week, as shown in Table 1, and the number of social learners decreased across the weeks. The number of comments also dropped from Week 1 to Week 3, but rose for the final week.

Table 1. Number of Social Learners and Comments in Each Course Week

	Social Learners	Comments
Week 1	520	2814
Week 2	370	2972
Week 3	294	2278
Week 4	270	2332

6.2 Data Analysis

All comments posted in the courses were categorized into the five proposed types and are shown in Table 2. There were more lone posts than initiating posts, yet replies were the most frequent comment types in this course. Additionally, some learners did engage in turn-takings, i.e., responding to others' replies to their own posts or replying again under an initiating post, although the number of responses and further replies were lower than the other categories. This could be due to the fact that they could only happen when an initiator receives a reply for their posts so that they could respond, or when there are other learners replying after a learner has replied to an initiating post.

As argued earlier, an overview of the distribution of the comments at the course level may not be informative for unpacking the social engagement among learners in the discussion activities in FutureLearn. We thus investigate the distribution of each type of comments at three levels: conversations, learners and course step design, corresponding to the three research questions raised.

Table 2. Distribution of Each Type of Comments

Types	Number of Comments	%
Initiating Posts	1868	18%
Lone Posts	2651	26%
Replies	4113	40%
Responses	718	7%
Further Replies	1046	10%
Total	10396	100%

7. CONVERSATIONS

Research Question 1: What are the characteristics of conversations occurring in the FutureLearn discussions?

7.1 Analysis and Results

A conversation is started by an initiating post and composed of all the replies, responses and further replies underneath it. Thus the number of conversations is equal to the initiating posts, which is 1868 in this course. These initiating posts were contributed by 407 social learners, whilst all the conversations involved 510 social learners (including both initiators and replying learners). Fourteen percent of the initiating posts in a conversation elicited more than five turns, *i.e.*, replies, responses or further replies together, which was more than the 2.5% shown in [25] findings on their FutureLearn courses. There were 72 conversations with more than ten turns, the longest of which consisted of 51 turns. Table 3 shows the number and percentage of conversations identified based on the number of turns, number of responses contributed by initiator, replies and further replies contributed by replying learners, and number of unique learners involved.

The longest conversation in this course happened in a step that is without a discussion prompt. The initiating post was the initiator's[1] interpretation of a cartoon on that step that portrayed "*the 'rich' family had one child and the 'poor' had two … some people have children they cannot afford but expect someone to pick up the tab by having more benefits …*". This initiating post garnered 38 replies from 13 learners and the initiator responded to them 13 times. This, along with another 14 conversations with more than 20 turns, might make a case study for conversational analysis about learners addressing a controversial issue among themselves. At the same time, this finding also suggests that not only discussion prompts designed by educators, but also contents of initiating posts contributed by learners could generate discussion. A comparison between lone posts, initiating posts with only one reply and initiating posts eliciting more than 20 turns might help us to understand more about learners' roles in initiating conversation in MOOCs. The first reply in each conversation may also need to be taken into account, to understand if the reply stifles further conversation or if it is simply a supportive statement to a reflective

[1] The comment data retrieved did not contain learners' name and the registration for this run of the course had ended before we started the analysis, so there is no way for us to obtain consent from learners to cite their comments, or to acknowledge them under the terms of Creative Commons License. Therefore, we anonymized them instead to protect their privacy.

post that hardly invites replies, given that there were 714 conversations (38%) with only one reply.

Table 3: Overview of Conversations

Nature of the conversations	Number	%
Conversations with only 1 reply	714	38%
Conversations with more than 5 turns	254	14%
Conversations with more than 10 turns	74	4%
Conversations with at least 20 turns	15	1%
Conversations with initiator's responses, i.e., repeated occurrence of the initiator	473	25%
Conversations with further replies, i.e., repeated occurrence of replying learners	434	23%
Conversations with both initiator's responses and further replies from others	210	11%
Conversations involving more than 5 unique learners	97	5%
Conversations involving more than 10 unique learners	12	1%

Secondly, in 473 conversations, learners who contributed the initiating post responded to replies from others at least once, and there were eleven conversations in which the initiators responded more than five times, and 107 conversations in which the initiators responded two to five times. A conversation with large number of responses may imply a conscientious initiator who responds to each reply he/she receives. Furthermore, in 410 conversations, learners who replied to the initiating post further replied at least once after other learners reply after their first reply. Among these conversations, there were 36 conversations contained more than five further replies. In short, in almost a quarter of the conversations generated in this course, learners engaged in turn-takings by getting back to each other on issues raised in their comments. It also pointed to the fact that, despite its simple commenting structure, there are turn-takings and discourse structure in the discussion in FutureLearn, and this information has not been captured in previous content analysis research in MOOC discussion where postings were analyzed individually.

Comparing these conversations to those where learners did not respond to each other may also reveal the different types of conversations happening in the MOOC discussion. For example, in one instance, the response from the initiator to others' replies seem to summarize the conversation, "*I think that this is the problem and why the model we were shown in the diagram above and other models and diagrams, doesn't work.*" However, there seem to be many arguments when learners responded to each other under one initiating post, so responses and further replies in these conversations could be studied in detail to understand how learners react to each other, especially when there is a disagreement. In contrast, there were 169 conversations receiving at least three[2] replies but without any learners commenting more than once, i.e., nobody responding or replying again after their first replies under the initiating post or after they created the initiating post. Specifically, there were 29 such conversations with five or more replies from different learners, and this begs the question of how these replies from different learners make up a conversation. Examination of one such conversation shows that the initiating post was a sharing of a video URL and that all five replies were an expression of gratitude towards the sharing. Another conversation with all eight replies from different learners, however, revealed that four of the replies were targeted to two of the replies posted at the start of the conversation, and each reply built on the initiating post.

Additionally, there were 12 long conversations involving more than ten unique learners, containing replies, and responses from initiators or further replies from some of the replying learners. In one such conversation, six out of the ten learners involved addressed the initiator's name at the start of their replies. At the same time there were replies addressing four other learners by name in the same conversation. Such conversations seem to be containing multiple sub conversations directed to the initiator, and overlapping turn-taking between different pairs of learners, similar to other computer-mediated communication such as Facebook [23] and Internet Relay Chat (IRC) [9].

7.2 Interim Discussion

The analysis above showed that the conversations in FutureLearn could be characterized by the number of turns, presence of responses or further replies and number of unique learners involved, despite the complexity revealed. A thorough conversational analysis on the different types of conversations identified above will surely unravel this complexity further and answer some of the questions arising from the findings, including how initiating posts, instead of lone posts, elicit conversations, how learners react to each other when they engage in turn-takings, and how multiple learners engaged in a single conversation.

On the other hand, this analysis could be a learning analytic tool for educators and mentors as they look into conversations with an unusual number of turns, responses, further replies, unique learners while monitoring the discussion activities when the course was still running. Conversations attracting huge number of learners or comprising repeated exchanges between few learners may contain some heated discussion in need of intervention by educators or mentors. For example, in a conversation with ten replies and seven learners, the last reply started with "*Thanks for the insult XX. A problem with the public schools is that …*" Although the 'like' function may have helped educators filter for popular posts, it was found that in this course, there were 43 initiating posts receiving more than ten turns, but fewer than five 'likes'. Therefore, besides 'like', the replies and social dynamic measures of each initiating post will also help to focus attention of educators or mentors among the overwhelming comments contributed by learners.

8. SOCIAL LEARNERS

Research Question 2: Are there different groups of social learners with distinctive commenting behaviours?

8.1 Analysis and Results

Based on the types of comment contributed and the replies received by each social learner, we can identify seven groups of learners who shared similar commenting patterns, that could in turn be subjected to further analysis or intervention during the course period.

Group 1: Loners

[2] Three turns are used as a cut-off for the conversations because in theory, the earliest turn a learner could further reply is in the third turn, after he/she replies in the first turn, and the other learner replies to his/her reply in the second turn.

165 (25%) out of the 641 social learners never received a reply from others either for their own new posts or their replies under others' initiating posts, although 111 of them received at least one like for their posts or replies. Among them, 131 contributed only lone posts, 20 contributed only replies, and 14 contributed both lone posts and replies. All except three of them commented fewer than 10 times, which might decrease the probability of their postings being seen and replied to. Some of them might have dropped out of the course, yet 71 of them completed at least half of the total steps in the course. 82 of them only commented in week 1, whereas the remaining 83 commented in other weeks. The inconsistency and infrequency of their commenting at the start of the course made it hard to tell whether or not receiving no reply dissuaded them from contributing any further to the discussion.

We examined all the comments by one loner. This learner created new posts and replies 14 times across the four-week course period but never received a reply and received only one like. Four of his/her lone posts and one reply stated only *"I agreed"*, which did not provide substance to invite replies. In his/her longest lone post, *"i am single and not thinking to buy a house as far as i am single but for my family kinds and wife i prefer to buy a own[sic] house ……we can profit in the end mortgage a house in term of mone*y," there seems to be no sign of inviting others to comment. But he actually answered the discussion prompt *"Do you rent or buy"* that encourages self-reflection. He/she raised a question in one of his/her lone posts, but without a question mark, "*i paid, tax, unemployment insurance and pension from my salaries, how it would effect [sic] me if i will no longer live before i would able to use them*." It seems that this learner needs to improve his/her commenting skills and English writing, especially in elaborating his/her ideas and making his/her questions explicit so that other learners would have something concrete to comment on. Nonetheless, this learner completed the course despite not receiving replies from others.

There was one loner who only contributed one post which received 12 likes despite not receiving any reply. It was a reflection on his/her pension choice in response to a discussion prompt in week 2, *"I am retired so have some experience of the different schemes and what they might buy in retirement. I was very lucky to have a final salary scheme …. The problem with personal pensions is that you are at the mercy of the insurance companies… Saving throughout your working life for retirement does not necessarily mean you will receive the sort of income you envisaged."* This comment resembles life advice from a senior that you will listen to rather than replying back. Another loner also commented once only by sharing information during week 3 about housing issues in his/her country by saying "*Here in Hungary, 80 % of the population have own property (flat or house). I live with my parents, we have a house*," without receiving any likes or replies. These two lone posts provided information and personal story only without reference to others' viewpoints or invitation for others' input. They could be considered monologic, and this might be the reason for not receiving any reply [17]. This preliminary analysis of the three loners' comments showed that lone posts could be of varied nature.

Group 2: Active Social Learners

94 out of the 641 social learners contributed all five types of comments. Sometimes their posts initiated a conversation, sometimes they were lone posts. They replied to others under an initiating post, responded to those who replied under their initiating posts, and further replied after their replies in others' initiating posts. Another 87 social learners were also similar to this group, except that one of them always received replies from others and never had a lone post, 27 of them never responded to others under their initiating posts but further replied to others under others' initiating posts, 51 of them never further replied under others' initiating posts but responded to others under their own initiating posts, and eight of them always received replies from others and either never responded or further replies. Although they did not contribute all five types of comments, these learners initiated posts that received replies, replied to others' posts and engaged in turn-taking as indicated by responses or further replies. Therefore, they were considered as active as the 94 learners who contributed all five types of comments. Putting these learners together, there were 181 active social learners in this course, comprising 28% of all social learners. 158 of them completed at least half of the course, and 83% of them commented more than ten times.

Group 3: Initiators

114 learners contributed only new posts (both initiating posts and lone posts) but never replied to others' initiating posts despite receiving replies from others. Among them, 41 always had people replying to their posts, whereas 73 of them sometimes had lone posts that received no reply. Both groups never responded to others' replies under their initiating posts. Nonetheless, 91% of them did not contribute more than 10 posts. Yet, there were two initiators each created 90 new posts, with only 31 and 8 posts receiving replies respectively.

Interestingly, there were three initiators received more than 10 replies to one of their initiating posts yet they never responded. One of them had been asked by other learners in their replies to him/her throughout the course for copying others' comments. The other one made only two initiating posts, both about state benefits. In both conversations initiated, there were replies for and against the initiator's negative attitudes towards those who claim benefits. The shorter initiating post was *"where i live work is a four letter word and they would love to receive[sic] a share without contributing, even when they can."* which elicited ten replies among six learners. The first reply asked *"So you or your parenst[sic] has never received child benefit, used the NHS or attended state school?"* and one spoke for the initiator by saying *"…we don't know what is happening there, and therefore can't really criticise her comments"*. The third initiator made only one post," *All animals are equal, but some animals are more equal than others. George Orwell, Animal Farm*", with the first reply asking "*Ah, XXX, but what chances of change? Are all politicians hypocrites wh[sic] won't effect change?*"

From these excerpts, it seems that initiators provoked some discussion about politics, and they might be unwilling to respond to others' 'hostile' replies or views which were different from them. This awaits a full analysis of the initiating posts and the replies to them. Yet, it indicates a need to monitor long conversations, especially when the initiator is not responding at all.

Group 4: Initiators who responded

37 learners responded to others' replies to their initiating posts, yet they never replied to others' initiating posts. They were similar to the initiator group except they responded under their initiating posts. In one instance, the learner responded to a reply full of strong language. Their initiating post was *"The course comments have become a happy hunting ground for left wing/right wing prejudices. I welcome the presentation in the course of arguments derived from a broad base of statistical data,"* which attracted one hostile reply "*Can you explain to me what is wrong with people putting their various analysis of the circumstances they see in the world… I presume, despite your lip service to balance- that views…*". The

Table 5: Groups of Social Learners

Groups	Distinctive Features	Number of Learners	Learners with more than 10 comments
Loners	Never received replies	165	3
Active social learners	Initiated posts, replied to others, and responded or further replied	181	151
Initiators	Never replied or responded	114	8
Initiators who responded	Never replied but responded to others' replies	37	9
Interlocutors	Only replied to others	40	3
Active social learners without responding and further replying	Initiated posts, replied to others but never responded or further replied	98	30
Reluctant active social learners	Created lone posts, replied to others, further replied	6	4

learner of the initiating post in turn responded with "*I believe in open discussion and strive not to be judgmental. However I confess to a prejudice towards discussion that is illuminated by hard evidence.*" Presumably, not every learner had the courage to respond to such a hostile reply, and might choose to keep quiet, as the example in the initiator group suggests.

Group 5: Interlocutor

60 people only replied to others without creating their own initiating posts. 20 of them have all their replies as the last reply under an initiating post, i.e., nobody replies after them, and were already categorized as loners above. The remaining 40 people sometimes attracted replies after their replies under an initiating post, although we could not determine if the replies were targeted to their replies without considering the content of the replies. Only three of them contributed more than 10 replies throughout the course, and nine of them engaged in further replies after other learners replied after them.

Group 6: Active social learners without responding or further replying

75 learners contributed initiating posts and lone posts, and also replied to others' initiating posts, but never responded or further replied. Although they received replies for their initiating posts, they never responded to those replies. Similarly, they never replied further after other learners replies after them under the same initiating post. Although they never got back to others on the issues they commented before, they were still considered active given that they created new posts as well as replied to others' initiating post. Additionally, there were 23 learners behaved similarly except that they were not so fortunate to receive any reply for their new posts such that they did not have any initiating posts. In sum, there were 98 learners in this group.

Group 7: Reluctant active social learners

Lastly, six learners could be considered reluctant social learners as they created new posts, replied to others' initiating posts, and engaged in turn-taking by replying further when other learners replied after they replied under an initiating post. They could be similar to the active social learners, just that they were not so fortunate to receive any replies to their lone posts. All of them contributed more replies than lone posts.

8.2 Interim Discussion

Table 5 summarizes the classification of the social learners discussed above and their distinctive features. This classification shows that the learners' commenting behaviour in FutureLearn is not homogenous and could be distinguished by the types of comments they contributed and replies received. There are three prominent groups in this course, namely active social learners, loners and initiators, and four minority groups. Learners commenting more than ten times mainly come from the three groups of active social learners, whereas more than half of the social learners (68%) commented ten times or fewer. The content of the comments and learning experience of the different groups of social learners warrant further research to understand the discussion activities in MOOCs. Analyzing comments contributed by individual learners from each group by using well-established content analysis frameworks, discourse analysis or conversational analysis will further shed light on social learners and inform course educators about their audiences, although social learners comprised only about one third of all the learners. Conducting in-depth interviews with learners from different groups about why and how they comment in the discussion might triangulate findings from the analysis of their comments, especially the initiators whose comments are only restricted to new posts, interlocutors who reply only and loners who contribute very few posts.

This classification also allows educators or mentors to target specific groups of learners for discussion monitoring. We suggest automatizing classification of learners in the middle term of the course, and looking into some of their latest comments for interventions. For loners, educators could reply to them by asking them to elaborate more on their arguments, or direct other learners to read their posts that are worthy of commenting. For initiators, educators may want to encourage them to either reply to others' posts or responded to others' replies to their initiating posts. However, as mentioned earlier, some initiators did not respond probably because of the hostility expressed by others' replies to their controversial initiating posts, so educators might want to look into the replies they received at the same time.

9. Course Step Design

Research Question 3: Is there a relationship between course step design and distribution of comment types?

9.1 Analysis and Results

Within the 91 steps that allow commenting in this course, 76 steps were dominated by replies, 15 steps by lone posts, whereas lone posts were the least in seven steps, responses in 48 steps and further replies in 36 steps. Closer inspection shows a difference among steps. For example, lone posts (53%) dominated step 1.2, which was the introduction to the course, and most posts were self-introduction. In contrast, in step 1.3, there were overwhelmingly more replies (43%), compared to initiating posts (17%) or lone posts (15%), suggesting learners were explicitly interacting with

each other. In fact, step 1.3 was a series of explanations of terminology without any explicit discussion prompts, except the title "Inequalities of what?" Perhaps this is a big question and learners are at the initial stage of concept formulation, so they tended to discuss with each other without the need of being prompted. In contrast, in the dedicated discussion step 1.18, lone posts (60%) dominated. This might be due to the fact that the discussion prompt *"Think about the factors influencing your own income and consumption profile so far and what you expect in the future"* asked for self-reflection rather than discussion and it is highly likely that learners were not critical or judgmental of others' personal choices and circumstances.

To systematically examine the relationship between course step designs and distribution of comment types, we conducted a preliminary analysis on the design of each course step based on the content in each step. The first author went through every step of the course as a learner, by watching all the videos and reading all the contents. However, no comment was read, in order to avoid any bias that might arise when we examined the relationship between course step design and comments posted by learners. After four iterations of categorizing the course step, five major categories were drawn, although there are 27 steps in the course that remain unclassified due to their multiple components. Therefore, in this exploratory study, we are only investigating 64 course steps that could be classified into the five categories we have come up with for this particular course:

1. Concept (18 Steps): explanation of concepts by using definitions
2. Countries comparison (11 Steps): concepts are explained and relevant issues are compared across countries, accompanied by graphs or charts.
3. Discussion (14 Steps): all dedicated discussion steps are included in this category because in this course, explicit questions are only raised in these steps. However, there are nuanced differences among the questions.
4. Expert opinion (12 Steps): expert opinions were featured either by their speech shown in a video or by summary of their published works.
5. UK issues (9 Steps): explanation of concepts with a focus on the UK, although it should be noted that UK affairs were constantly mentioned throughout the course.

Table 6: Comment types and course step design

Course Step Design	Initiating Posts	Lone Posts	Replies	Responses	Further Replies
Concept	261	193	630	109	137
Countries comparison	151	152	408	52	98
Discussion	596	1341	1023	194	208
Expert Opinion	268	246	655	112	206
UK issues	115	96	276	53	82

A chi-square statistical test showed that the distribution of comments types is significantly associated with course step design, $\chi^2(16) = 623.68$, $p<.001$ (Table 6). Particularly, replies seem to be the most frequent types of comments in all course step designs except in the discussion steps, where lone posts dominated. This is rather counter-intuitive given that discussion steps are intended for learners to discuss with each other. However, in this course, quite a few discussion prompts ask for reflection about one's own financial status, the pension scheme of one's own country or personal choice on housing, so learners might not reply to each other. Further analysis is needed for all the discussion steps and the comments posted. Another surprising result is that the course steps dedicated for explaining concepts attracted fewer lone posts than assumed by the null hypothesis distribution in the chi-square goodness of fit test. One possible explanation is that most concepts introduced in the course are universal to all countries and people, so learners had a shared topic such that they could relate and reply to others' post more easily. Similarly, steps featuring country comparisons and UK, also garnered more replies, and fewer lone posts. Lastly, expert opinions not only elicited more replies but also more further replies than expected by the null hypothesis distribution. Learners seemed to be engaging in more turn-takings when discussing about opinions by eminent experts.

9.2 Interim Discussion

Overall, this results suggest that learners tended to interact with each other even without a prompt as long as there is a shared topic or a prominent opinion to converse about. It could also be possible that learners not only engaged in conversation with oneself when first encountering a concept, but also attempted to modulate or expand it by communicating with peers [15]. Although this result seems to suggest that the discussion steps do not produce learners' interaction as desired, it awaits future research on the nature of discussion prompts in each step, to determine whether the prompt is designed for reflection or is not well-designed to get learners to talk to each other. An ad hoc analysis revealed that only one discussion step has a very high volume of replies (more than double of lone posts), and the step was presented with arguments against austerity measures in the UK, which inevitably provoked more discussion among learners, the majority of whom were presumably based in the UK.

Despite being inconclusive, this preliminary analysis demonstrates the potential of quantifying discussion activities in relation to course steps, such that educators could be informed of the unusual number of comment types in a particular course step, and intervene while the course is still running or make revision of the next run of their course accordingly.

10. DISCUSSION ANALYTICS

As argued in the interim discussions, the analytics of the five comment types at the level of conversations, social learners and course steps could be leveraged for research on FutureLearn discussion activities, course monitoring or course revision. The analytics are visualized below.

1. Conversations

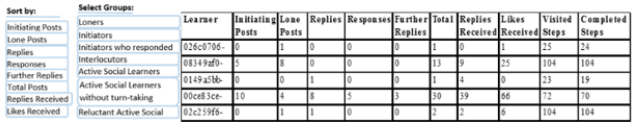
Conversations	Step	Replies	Responses	Further Replies	Turns
4365989 Go To	2.2	5	10	15	30
4374103 Go To	2.5	5	12	9	26
4352189 Go To	2.1	7	1	15	23
4357380 Go To	2.6	12	0	10	22
4357488 Checked	2.12	8	4	9	21

Sort by: Replies | Responses | Further Replies | Turns

Figure 1: Prototype Dashboard on Conversations in Week 2

In a weekly dashboard on conversations (Figure 1), educators and researchers could sort the conversations according to the types of comments and the total number of turns composing them, or the unique learners involved (equal to the number of replies), and be directed to the initiating post that elicits the particular conversation by clicking on the conversation ID, such that they could read or analyze all the replies underneath the initiating post.

2. Social Learners



Learner	Initiating Posts	Lone Posts	Replies	Responses	Further Replies	Total	Replies Received	Likes Received	Visited Steps	Completed Steps
026c0706-	0	1	0	0	0	1	0	1	25	24
08349af0-	5	8	0	0	0	13	9	25	104	104
0149a5b6-	0	0	1	0	0	1	4	0	23	19
00ce83ce-	10	4	8	5	3	30	39	66	72	70
02c259f8-	0	1	1	0	0	2	2	6	104	104

Figure 2: Prototype Dashboard on Social Learners

As suggested earlier, different groups of social learners could be visualized when the course is half-way through so that educators could support identified individuals for the remaining of the course. In the dashboard (Figure 2), educators could filter for a particular group of social learners, and sort according to the number of comment types contributed, replies or likes received, and then be directed to the comments contributed by individual learner by clicking on their ID.

3. Course Step

Step	Total	Initiating Posts	Lone Posts	Replies	Responses	Further Replies	Longest conversations	Learners involved
1.1	291	54	87	98	30	22	16	168
1.2	83	11	44	22	4	2	9	114
1.3	162	28	25	70	19	22	30	74
1.4	132	21	25	54	13	20	22	75
1.5	50	7	16	22	2	3	9	66

Figure 3: Prototype Dashboard on Each Course Step

Lastly, a dashboard highlighting the most and the least frequent types of comments in each step could be created (Figure 3). Educators then could identify a step that has unexpectedly generated too many comments of a certain type that is not in line with their teaching objective. For example, if a discussion step elicits more lone posts rather than replies or responses, the educators may want to modify their discussion prompts for the next course run, or intervene while the course is still running by posting comments directing learners to some lone posts that are worth reading and commenting, or by posting more comments to guide learners how to create initiating posts.

This visualization awaits to be developed and tested with educators to evaluate its implication in course monitoring, especially its function in sifting through the sheer number of comments posted in the discussions activities [12]. The discussion analytics visualized here are automated from the comment data provided by FutureLearn to partner institutions who offer courses through its platform. It does not require intensive manual coding or accuracy check for machine learning because the categorization is purely based on the commenting structures of FutureLearn. Most importantly, it provides a systematic way for both educators and researchers to leverage the data currently available for the investigation of the patterns of conversations and social dynamics in the discussion activities in FutureLearn.

11. GENERAL DISCUSSION

To unveil the patterns of discussions among learners in FutureLearn, we categorized the comments in a FutureLearn course into five types: *initiating posts* that receive replies, *lone posts* that receive no replies, *replies* to others' initiating post, *responses* to others' replies to one's own initiating posts, and *further replies* when one replies again to an initiating post. This categorization could be further applied at the level of conversations and social learners. Beside the number of replies each conversation involves, conversations under each initiating post also vary by the presence of initiator's responses, replying learners' further replies, number of unique learners involved. Lastly, based on the types of comments contributed and the replies received by each social learner, seven groups of learners were identified. The preliminary quantitative and qualitative analysis based on these three categorizations revealed the heterogeneity of social learners as well as the complex social dynamics that happened in a FutureLearn course. At the same time, these categorizations provided an analytics method for educators and mentors to negotiate through the seemingly overwhelming discussion postings. Educators could identify conversations, course steps and learners with an unusual number of certain types of comments and intervene accordingly during discussion monitoring or use this information to revise their course step design for the next run. Lastly, these categorizations also set the scenes for future research on FutureLearn discussion activities such that researchers could base their analysis on certain categories of interest to them. Below we highlight the theoretical basis of our categorization of comments and several findings from our preliminary analysis that warrant further investigation.

The proposed categorization extended previous research [14, 27] on MOOC discussion that analyzed postings individually by taking into account social dynamics and discourse structures. The differentiation between new posts (both initiating posts and lone posts) and replies (replies, responses and further replies) reflects the computer-mediated discourse that learners engaged in [10]. Similar to other computer-mediated communication, creating a new post normally is to address all learners in general, whereas replying to a specific post is to target the initiator of that post or other learners who have replied to that post. This difference between a conversation in the global context of a course step and a conversation contextualized to an initiating post is well illustrated by the fact that most discussion steps in this course generated more lone posts, whereas the longest conversation with 51 turns was elicited by a provoking post in a step without any discussion prompt. This finding also pointed to the fact that not only discussion prompts and course steps designed by educators could generate discussion, but learners also play a role in eliciting discussion. The differentiation between an initiating post and lone post thus provides us a way to examine how learners' post could elicit discussion. Furthermore, a differentiation between initiating posts attracting one reply and many replies, and analysis of the first reply under each initiating post might provide additional insight on learners' role in discussion generation.

Secondly, we recognized turn-takings in a conversation by identifying responses and further replies, which are contributed by learners who came back to a conversation that they initiated or replied before. Analyzing conversations with such turn-takings might reveal how learners react to each other, especially when there is a disagreement. On the contrary, conversations without such turn-takings beg the question about why there is a lack of responses or further replies, and how a conversation could be sustained by multiple interlocutors who only contributed once. As shown in the example cited in this paper, hostile replies might put learners off from responding or replying again to engage in turn-taking. On the other hand, within both conversations with and without turn-taking, multiple sub-conversations exist such that individual learner may only address a specific reply among the many replies underneath the initiating post. This phenomenon might be similar to other computer-mediated communications where users only addressed the initiating post or one of the many replies underneath it [9, 23], by using linguistic strategies such as name addressing or back-channeling to indicate their intended target user [11]. An investigation of these strategies among the FutureLearn learners, especially in a conversation longer than ten turns, will provide an insight on how learners negotiate through the sheer number of comments in MOOC discussion.

Although our preliminary analysis on the different types of comments and conversations have been mainly qualitative in nature, it is possible to conduct quantitative analysis to understand the social dynamics and discourse in MOOC discussion. Chen and Chiu [2] used content analysis and dynamic multi-level modelling to take both the content and sequential nature of discussion postings into account in their research on a university course class forum. They found that earlier messages that expressed disagreement or new ideas were more likely to elicit replies from others. It is possible that the conversations we analyzed in this paper were elicited by initiating posts or replies with such contents, and this warrant future research. Under our categorization framework, their method could be applied to the level of initiating posts and lone posts to understand how the discussion evolves in a particular course step. It could also be applied to the conversational level under each initiating post with an additional variable that differentiates replies, responses and further replies. However, their content analysis framework was tailored to the sequential nature of discussion, and was different from the well-established content analysis framework [5, 8] that considered messages individually.

Besides considering the social dynamics of discussion postings, we also conducted a preliminary quantitative analysis to investigate the relationship between the distribution of comment types and course step design, given that teaching design could facilitate learners' conversation with themselves and others [16]. FutureLearn "discussion in context" approach allows such an analysis on the course step levels, compared to the centralized discussion forum in other MOOC platforms that is detached from course step design. However, the results in this paper showed that discussion steps seem to elicit more lone posts than other steps in this particular course that we analyzed. Further analysis on the prompts in each discussion steps may shed more insights on design and conversation generated, as Golanics and Nussbaum [7] found in an experimental study that goal instruction and question elaboration in discussion prompts promoted more argumentation in a university course online discussion forum.

Lastly, this paper also recognized the individuality of various types of social learners when previous MOOC research has only focused on a minority of super-posters [13]. Further analysis of learners' comments and personal backgrounds such as education levels and language abilities, as well as in-depth interview on their experiences and learning strategies related to participation in discussion will provide valuable insights to educators and MOOC designers to better understand the different groups of social learners.

12. CAVEATS

Admittedly, the categorization of comment types in this paper is based solely on the structure in the discussion activities such that the categorization label for some comments may not be valid in light of their content. Specifically, a lone post in our categorization may not be 'lone' in content, but could be addressing comments that have been posted earlier [8], and/or could be similarly responded to by subsequent comments. For example, "*I see comments about Australian pensions… does anyone have a link to information as to the level of pensions and how they are funded across the developed world*.". There was a lone post that even explicitly mentioned the name of the other learner, *"I agree with XX. State pension system is as good as it gets. …."* These learners might choose not to reply directly to the other learners perhaps because there were too many learners with similar ideas to reply to. As discussed earlier, these lone posts may be components of a conversation at the global level in a course step that address all learners in general.

Nonetheless, these posts were considered lone posts as they were standalone, and in the FutureLearn system, such posts will not trigger notification emails to any learners, and will not receive notification from anybody, except when being 'liked'. This is in contrast to initiating posts whose poster will receive notification for every reply received, or a reply that will trigger notifications to the initiator whose post it replies to and other learners who replied before the reply. Therefore, lone posts also differ from the other four comments types on the ground of this interactional feature.

The second issue with this categorization concerns with vicarious learning and learners who do not post. It is possible that some of the learners who do not take part in the discussion activities (67% in the course analyzed in this study) read and 'like' some of the comments. However, we do not know who likes what from the data provided, therefore we could not incorporate it into our categorization of learners. Besides, it is possible that the initiators who never replied or responded might have read and liked others' posts or replies, rather than fixating on their own initiating posts only. Another way of determining if initiators read others' replies to them might be the data of them clicking the notification sent to them when they receive replies. On the other hand, the 'like' count has allowed us to establish that lone posts received 'likes' despite not receiving replies whereas initiating posts could receive many replies but without any 'likes'. Still, in this exploratory study, we did not add this dimension into our categorization of comment types and conversations, mainly due to the fact that no solid basis has been established to operationalize the 'like' count, for example, the cut-off point to differentiate between well-liked and less-liked comments.

Third, the classification of social learners is based on the types of comments contributed across the whole course periods. It did not take into account the number and proportion of different types of comments contributed, 'like' received by each social learners, as well as the weekly participation in the discussion activities, although it is found that not every social learners commented every week in this course and learners in FutureLearn do not necessarily engage with course materials every week [3]. However, an earlier attempt in our cluster analysis in trying to include weekly participation and proportion of different types of comments resulted in too many groups that elude any meaningful interpretation. Nonetheless, our classification successfully identifies every social learners, instead of only the super-posters who received attention so far in MOOC research [13].

Fourth, the comments quoted in the present paper are not representative of all the comments in the identified categories, conversations or group of social learners. They happened to be the first instance to show up when we filtered for the examples. A systematic analysis of the contents of each comment by using well-established content analysis techniques reviewed in the introduction, conversational analysis or discourse analysis [11] is warranted to further shed light on the characteristics of each type of comments, conversations and social learners identified by the categorization approach we proposed.

Lastly, the analysis is based solely on the first run of one course and this course is full of contentious issues due to its topic on inequality. The distribution of the comments types, conversations and group of learners may differ in other courses of different nature or course step design. Nonetheless, because the categorization is based solely on structural relationships, it could readily be applied to other FutureLearn courses. Additionally, an analysis of the other runs of

the same course will be particularly useful in understanding the relationship between the distribution of comment types and course step design presented in this paper. Consistent patterns may point to the influence of the course design whereas inconsistent patterns may reveal a cohort effect.

13. REFERENCES

[1] Bloom, B.S. 1956. *Taxonomy of educational objectives : the classification of educational goals. Handbook 1, Cognitive domain*. New York: David McKay Company.

[2] Chen, G. and Chiu, M.M. 2008. Online discussion processes: Effects of earlier messages' evaluations, knowledge content, social cues and personal information on later messages. *Computers and Education*. 50, 3, 678–692.

[3] Ferguson, R. and Clow, D. 2015. Examining engagement. *Proceedings of the Fifth International Conference on Learning Analytics And Knowledge - LAK '15*, 51–58.

[4] Ferguson, R. and Sharples, M. 2014. Innovative pedagogy at massive scale: Teaching and learning in MOOCs. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 98–111.

[5] Garrison, D.R., Anderson, T. and Archer, W. 2001. Critical thinking, cognitive presence, and computer conferencing in distance education. *American Journal of Distance Education*. 15, 1, 7–23.

[6] Gillani, N. and Eynon, R. 2014. Communication patterns in massively open online courses. *Internet and Higher Education*. 23, 18–26.

[7] Golanics, J.D. and Nussbaum, E.M. 2008. Enhancing online collaborative argumentation through question elaboration and goal instructions. *Journal of Computer Assisted Learning*. 24, 3, 167–180.

[8] Henri, F. 1992. Computer conference and content analysis. *Collaborative Learning Through Computer Conferencing*. 117–136.

[9] Herring, S. 1999. Interactional Coherence in CMC. *Journal of Computer-Mediated Communication*. 4, 4.

[10] Herring, S.C. 2007. A Faceted Classification Scheme for Computer - Mediated Discourse. *Discourse*. 1, 1–37.

[11] Herring, S.C. 2004. Computer-mediated discourse analysis: An approach to researching online communities. *Designing for virtual communities in the service of learning*. J.H. Barab, Sasha A ; Kling, Rob; Gray, ed. Cambridge ; New York : Cambridge University Press. 338–376.

[12] Hew, K.F. and Cheung, W.S. 2014. Students' and instructors' use of massive open online courses (MOOCs): Motivations and challenges. *Educational Research Review*. 12, 45–58.

[13] Huang, J., Dasgupta, A., Ghosh, A., Manning, J. and Sanders, M. 2014. Superposter behavior in MOOC forums. *L@S '14 Proceedings of the first ACM conference on Learning @ scale conference*.

[14] Kellogg, S., Booth, S. and Oliver, K. 2014. A social network perspective on peer supported learning in MOOCs for educators. *The International Review of Research in Open and Distributed Learning*. 15, 5.

[15] Laurillard, D. 2002. *Rethinking University Teaching: A Conversational Framework for the Effective Use of Learning Technologies*. RoutledgeFalmer.

[16] Laurillard, D. 2012. *Teaching as a Design Science : Building Pedagogical Patterns for Learning and Technology*. Hoboken : Taylor and Francis.

[17] Martin, J. R., White, P.R. 2005 *The language of evaluation: Appraisal in English*. Basingstoke: Palgrave Macmillan.

[18] Meltzoff, A.N. and Movellan, J. 2009. Foundations for a new science of learning. *Science*. 325, 5938, 284–288.

[19] O'Riordan, T., Millard, D.E. and Schulz, J. 2016. How should we measure online learning activity? *Research in Learning Technology*. 24, 1–15.

[20] Onah, D.F.O., Sinclair, J.E. and Boyatt, R. 2014. Exploring the Use of MOOC Discussion Forums. *Proceedings of London International Conference on Education*, 1–4.

[21] Rienties, B., Tempelaar, D., Giesbers, B., Segers, M. and Gijselaers, W. 2014. A dynamic analysis of why learners develop a preference for autonomous learners in computer-mediated communication. *Interactive Learning Environments*. 22, 5, 631–648.

[22] Sunar, A. S., Abdullah, N. A., White, S. and Davis, H. C. (2015) Analysing and predicting recurrent interactions among learners during online discussions in a MOOC. In, 11th International Conference on Knowledge Management ICKM 2015, Osaka, JP, 04 - 06 Nov 2015.

[23] Tagg, C. and Seargeant, P. 2015. Facebook and the discursive construction of the social network. *The Routledge Handbook of Language and Digital Communication*. A. Georgakopoulou and T. Spilioti, eds. Routledge. 339–353.

[24] Thomas, M.J.W. 2002. Learning within incoherent structures: The space of online discussion forums. *Journal of Computer Assisted Learning*. 18, 3, 351–366.

[25] Tubman, P., Oztok, M. and Benachour, P. Being social or social learning? A sociocultural analysis of the FutureLearn MOOC platform.

[26] Wang, X., Wen, M. and Rosé, C.P. 2016. Towards triggering higher-order thinking behaviors in MOOCs. *Proceedings of the Sixth International Conference on Learning Analytics & Knowledge - LAK '16* (New York, New York, USA, 2016), 398–407.

[27] Wang, X., Yang, D., Wen, M., Koedinger, K. and Rosé, C.P. 2015. Investigating how student ' s cognitive behavior in MOOC discussion forums affect learning gains. *Proceedings of the 8th International Conference on Educational Data Mining*. 226–233.

[28] Wise, A.F., Cui, Y. and Vytasek, J. 2016. Bringing order to chaos in MOOC discussion forums with content-related thread identification. *Proceedings of the Sixth International Conference on Learning Analytics & Knowledge - LAK '16* (New York, New York, USA, 2016), 188–197.